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Postprint / Postprint
Zeitschriftenartikel / journal article

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Empfohlene Zitierung / Suggested Citation:
Minondo, A. (2010). Exports' productivity and growth across Spanish provinces. *Regional Studies*, *44*(5), 569-577. https://doi.org/10.1080/00343400902783255

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Journal:	*Regional Studies*
Manuscript ID:	CRES-2007-0358.R2
Manuscript Type:	Main Section
JEL codes:	F14 - Country and Industry Studies of Trade < F1 - Trade < F - International Economics, O40 - General < O4 - Economic Growth and Aggregate Productivity < O - Economic Development, Technological Change, and Growth, R11 - Regional Economic Activity: Growth, Development, and Changes < R1 - General Regional Economics < R - Urban, Rural, and Regional Economics
Keywords:	Spain, exports, productivity, growth

Exports' productivity and growth across Spanish regions

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Received November 2007; in revised form May 2008, August 2008; accepted September 2008

Abstract

According to recent studies, countries specialised in goods associated with high productivity levels grow faster than countries specialised in goods associated with low productivity levels. In this paper we analyse whether that relationship also takes place at the regional level. Using a unique, highly-disaggregated, regional trade database, we calculate the productivity level associated to Spanish provinces' exports and analyse whether provinces that latch on more productive exports have achieved higher rates of growth. Our results show that there is also a positive link between exports' productivity and growth at a regional level.

Keywords: Spain, exports, productivity, growth

La productivité des exportations et la croissance à travers les régions espagnoles.

Minondo

Selon des études récentes, les pays qui se spécialisent dans des biens associés à des niveaux de productivité forts se développent plus vite que ne le font les pays qui se spécialisent dans des biens associés à des niveaux de productivité faibles. Cet article cherche à analyser si, oui ou non, ce rapport vaut au niveau régional. A partir d'une base de données unique sur le commerce régional très désagrégée, on évalue le niveau de productivité associé aux exportations des régions espagnoles et analyse si, oui ou non, les régions qui exploitent des exportations plus productives ont réussi des taux de croissance plus élevés. Les résultats laissent voir que la productivité des exportations est en corrélation étroite aussi avec la croissance sur le plan régional.

Espagne / Exportations / Productivité / Croissance

Exportproduktivität und Wachstum verschiedener spanischer Regionen

Asier Minondo

Abstract
Aktuellen Studien zufolge wachsen Länder, die sich auf Güter mit hohem Produktivitätsniveau spezialisiert haben, rascher als Länder, die sich auf Güter mit niedrigem Produktivitätsniveau spezialisiert haben. In diesem Beitrag analysieren wir, ob diese Beziehung auch auf regionaler Ebene zutrifft. Mit Hilfe einer eindeutigen, hochgradig desaggregierten, regionalen Handelsdatenbank berechnen wir das Produktivitätsniveau der Exporte spanischer Provinzen und analysieren, ob Provinzen mit produktiveren Exporten höhere Wachstumsraten verzeichnen. Unsere Ergebnisse lassen darauf schließen, dass auch auf regionaler Ebene eine Verbindung zwischen Exportproduktivität und Wachstum besteht.

Keywords:
Spanien
Exporte
Produktivität
Wachstum
JEL Classification: F14; O40

La productividad de las exportaciones y el crecimiento a través de las regiones españolas

Estudios recientes muestran que los países especializados en productos asociados a una alta productividad crecen más rápido que los países especializados en productos asociados a una baja productividad. En este artículo analizamos si esta relación también se produce a nivel regional. Utilizando una base de datos regional altamente desagregada, calculamos el nivel de productividad asociado a las exportaciones de las provincias españolas y analizamos si las provincias que se han especializado en productos asociados a una alta productividad han logrado un mayor crecimiento económico. Nuestros resultados muestran que también existe una relación positiva entre la especialización en productos asociados a una alta productividad y el crecimiento económico a nivel regional.

Palabras clave: España, exportaciones, productividad, crecimiento

JEL Classification: F14; O40

1. Introduction

There is long standing argument in the literature that specialising in some goods is more growth promoting than specialising in others. Back in the 1950s, in separated articles, PREBISCH, 1950 and SINGER, 1950, argued that there was a secular decline of the net barter terms of trade between primary products and manufactures. Due to this deterioration, countries that specialised in primary products would have a declining capacity to import manufactures, and among them capital goods, which would reduce their growth possibilities. Due to different reasons, other authors have also pointed out that specialising in natural resources may have depressing effects on economic growth (GYLFASON, 2001; SACHS AND WAGNER, 2001). According to this line of research, known as the natural resource curse, countries that specialise in primary products are prone to suffer Dutch disease problems and rent-seeking behaviour; moreover, wealth obtained from natural resources imbue people with a false sense of security that hinders the introduction of growth promoting policies, such as investment in human capital. Other authors have also argued that some sectors, due to learning by doing externalities, have a higher growth potential than others (YOUNG, 1991; MATSUYAMA, 1992). According to those authors, countries that specialise in sectors where productivity can be enhanced due to learning by doing (equated with manufacturing or high-tech sectors) will grow faster than those countries that specialise in sectors in which productivity is not improved through experience (equated with agriculture or low-tech sectors).

Recently, HAUSMANN, HWANG and RODRIK, 2007 (henceforth HHR) put forward another link between specialisation and economic growth. They argue that some commodities have a higher implied productivity level than others; in particular, HHR assert that commodities exported by rich countries are associated with high productivity levels, whereas commodities exported by poor countries are associated with low productivity levels. According to HHR if countries latch on high-productivity commodities they will grow faster than if they specialise in low-productivity commodities. A key contribution by HHR is the development of a quantitative index to rank commodities in terms of their implied productivity; based on this index, they also calculate the productivity-level associated to a country's exports. Equipped with this latter indicator they empirically test their model and, as expected, they find that countries specialised in high-productivity goods, relative to their income per capita, grow faster than countries specialised in low-productivity goods.

In the HHR model, growth occurs when resources are transferred from lower productivity products to higher productivity products[1]. In that model, specialisation patterns are not entirely predictable, because, along with fundamentals (labour, capital, natural resources and the quality of institutions), idiosyncratic factors also play a role in determining countries' comparative advantage. Hence, each country has a range of products, that differ in their implied productivity, in which it can specialise. However, the country does not know the exact commodity-composition of that range; it has to "discover" it. If entrepreneurs "discover" the high-productivity products within that range, economic growth will (temporarily) occur as resources are transferred to more productive activities.

In line with the HHR model, regional studies also have a large tradition of analysis on how specialising in some goods is more growth promoting than specialising in others. As explained by CAPELLO, 2007 since the late 1930s authors, such as Clark and Fischer, stressed that the process of regional growth was linked to the sectoral composition of the economy. The stages theory argued that regions moving from agriculture to industry would achieve higher rates of growth, due to the larger labour productivity in the latter sector. PIKE et al., 2006 note that specialisation in manufacturing also plays a large role in the Keynesian theories of regional divergence. For example, in Kaldor's approach, a region could achieve a higher productivity growth in manufacturing than in agriculture, because the former sector opens more possibilities to learn from experience. As PIKE at al, 2006 highlight specialisation in manufacturing is also important in Myrdal's circular and cumulative causation model of regional divergence. In this approach, manufacturing activities lead to agglomeration economies, which reinforce the advantage of regions that industrialise first. Myrdal's ideas can also be found in more recent economic geography models. For example, KRUGMAN, 1991 shows that regional specialisation is path-dependant, as the effect of economies of scale and external economies make some regions to get lock-in some industries. Based on those ideas, some economist have argued that public policy can play a role in the development of high-value industries characterised by external economies at a regional level. In particular, the nurturing of those industries' first activities through trade protection or tax incentives would put in motion the increasing returns that would reinforce the regional advantage (PIKE et al., 2006).

The aim of this paper is to analyse whether the link between trade specialisation and economic growth found by HHR at the country level also takes place at the regional level. In particular, we aim to investigate whether Spanish provinces (NUTS III) that have specialised in high-productivity goods have grown faster than provinces that have specialised in low-productivity goods. As a preliminary to our conclusion, we also find a positive link between provinces' exports productivity level and subsequent growth.

The remaining of the paper is organised as follows. The next section explains the construction of the quantitative index to measure Spanish provinces exports' productivity level. Section 3 presents data on Spanish provinces' exports productivity level. Section 4 studies the relationship between provinces' exports productivity and subsequent growth. The final section summarizes the paper's main findings.

2. The construction of an exports' productivity index

Following HHR, to construct the productivity-level associated to a province's exports indicator (EXPY), two steps are followed. Firstly, we compute the income level associated to each exported commodity. This indicator, denominated PRODY, is calculated as follows:

$$PRODY_i = \sum_j \frac{x_{ij}/X_j}{\sum_j \left(x_{ij}/X_j \right)} * y_j \qquad (1)$$

where x_{ij} denotes country j exports of product i, X_j country j total exports and y_j country j GDP per capita. The numerator of the weight, x_{ij}/X_j, is the share of product i in j country's total exports; the denominator of the weight, $\sum_j \frac{x_{ij}}{X_j}$, aggregates the shares of product i in total exports across countries. Hence, the weight reflects j country's revealed comparative advantage in product i. $PRODY_i$ is, therefore, the average of exporting countries GDP per capita, weighted by each country's revealed comparative advantage in product i.

Other studies, such as LALL *et al*., 2005, use the share of country *j*'s exports of product *i* in total world exports of product *i* as weight in the PRODY calculation. However, as noted by HHR, if this weight is used the PRODY indicator will be biased towards large countries' GDP per capita, because large countries export more than small countries. In order to overcome this limitation, the authors suggest the use of revealed comparative advantage as weight.

Secondly, the exports' productivity index, EXPY, is calculated as a weighted average of each exported commodity's PRODY, where the weights are the shares of each product in the country's total exports. Algebraically,

$$EXPY_j = \sum_i PRODY_i * \left({x_{ij}}/{X_j} \right) \qquad (2)$$

As HHR recognise, a shortcoming of PRODY, and hence of EXPY, is that it does not correct for differences in quality within a product category. For example, as RODRIK, 2006 shows, even at the Harmonised System (HS) 6-digit disaggregation level, which distinguishes more than 5000 product categories, there are large differences in terms of quality. Moreover, SCHOTT, 2004 points out that those differences are related with countries GDP per capita level. He shows that, within narrowly defined manufactures, there is a clear vertical differentiation across countries, with low GDP per capita countries specialised at the lower end of the quality spectrum and large GDP per capita countries specialised at the higher end of the quality spectrum.

If EXPY coefficients do not correct for differences in quality, we may overvalue or undervalue regional exports' productivity level. This under or overvaluation, on its hand, may compromise the validity of the econometric results. In order to control for quality differences in the PRODY and EXPY indicators, we follow the methodology developed by MINONDO, 2007. For each product, we calculate each country's exports unit value. Then, we sort unit values from the lowest to the highest value. In order to minimise the impact of measurement errors, we remove unit values which are below or equal to the first percentile as well as unit values that are equal or above to the 99th percentile. From the remaining unit values, we select the 33rd percentile unit value and the 67th percentile unit value. Exports whose unit value falls between the minimum unit value and the 33rd percentile are considered as low quality varieties; those exports whose unit value falls between the 33rd percentile and 67th percentile are considered as medium quality varieties, and finally, those exports whose unit value falls between the 67th percentile and the maximum unit value are considered as high quality varieties. We only calculate varieties PRODY if we have, at least, five unit value observations per each product.

Once we establish, for each product, the unit value ranges for each quality level, we calculate the PRODY value associated to each variety:

$$PRODY_{qi} = \sum_j \frac{\left(x_{qi,j} \big/ X_j \right)}{\sum_j \left(x_{qi,j} \big/ X_j \right)} * y_j \qquad (3)$$

where $x_{qi,j}$ denotes country j exports of product i's q variety, where q can be low, medium or high. As before, X_j denotes j country's total exports and y_j is j country's GDP per capita. Now, the numerator of the weight, $x_{qi,j} \big/ X_j$, is the share of product i's q variety in total exports; the denominator of the weight, $\sum_j \frac{x_{qi,j}}{X_j}$, aggregates the shares of product *i*'s *q* variety in total exports across countries. Hence, the weight reflects *j* country's revealed comparative advantage in product *i*'s *q* variety. $PRODY_{qi}$ is, therefore, the average of exporting countries GDP per capita, weighted by each country's revealed comparative advantage in product *i*'s *q* variety.

The EXPY indicator will now be calculated as follows:

$$EXPY_j = \sum_i \sum_{q=low,medium,high} \left(\frac{x_{qi,j}}{X_j} \right) PRODY_{qi} \quad (4)$$

which is a weighted average of each variety's *PRODY*, where the weights are the shares of each variety in total exports.

In order to calculate varieties' PRODY we use a sample of countries that reported export and GDP per capita data in 2002, 2003 and 2004[2]. Exports' data are total country's exports at the HS 6-digit disaggregation; these data are obtained from the UN Comtrade database; GDP per capita in PPP constant dollars are obtained from the World Bank's World Development Indicators database. The sample is composed by 115 countries. In order to reduce measurement errors, following CO (2007), and HALLAK and SCHOTT (2008), we drop from the analysis those observations where the value of exports is below 10000$. The sample accounts for 89 per cent of total world merchandise exports in the 2002-2004 period. We use Agencia Tributaria database's export data to calculate Spanish provinces' EXPY. The Data

Appendix describes how we treat data in order to calculate the quality-adjusted PRODY and EXPY indicators.

3. The productivity-level of Spanish provinces' exports

Table 1 presents Spanish provinces' quality-adjusted EXPY in 1994, in 2005 and the average annual growth rate between those years. In 2005 the average of Spanish provinces' quality-adjusted EXPY was 15612$.The Spanish province with the highest quality-adjusted EXPY was Huelva: 18870$. That province was followed by Ávila (18752$), Girona (18671$), Soria (18606$) and Huesca (18369$). In the bottom of the ranking we find Las Palmas (9431$), Almería (10209$), Tenerife (10259$), Cáceres (12211$) and Zamora (12640$). We can observe that the ratio between the province with the highest quality-adjusted EXPY (Huelva) and the province with the lowest quality-adjusted EXPY (Las Palmas) is around 2. With respect to 1994, we can observe that Tenerife was the province in the top of the ranking, followed by Salamanca, Ourense, León and Palencia; at the bottom of the ranking we find Ávila, Zamora, Almería, Granada and Badajoz.

[TABLE 1 AROUND HERE]

Differences in EXPY across Spanish provinces are explained by trade specialisation. Provinces that are located at the top of the ranking are characterised by a large specialisation in products with high productivity levels, such as motor vehicles, parts and accessories of motor vehicles, chemical products and medicaments. On the contrary, provinces that are located at the bottom of the ranking are characterised by a large specialisation in commodities with low productivity levels, such as agricultural products and minerals.

In principle, a larger specialisation in products associated with high productivity should be related with a higher GDP per capita: provinces that command a high GDP per capita should export goods associated with high productivity levels, whereas provinces that command a low GDP per capita should export goods associated with low productivity levels. If that were not the case, we would find an unbalance between provinces' income level and the productivity associated to their exports. For example, as the HHR model predicts, if a province exports goods associated to a productivity level that is higher that the one predicted by its GDP per capita, the province's GDP per capita will grow until a balance between EXPY and the income level is reached; on the contrary, if the province exports goods associated to a productivity level below its GDP per capita, the province ought to move its resources to more productive activities in order to keep its income level.

Figure 1 analyses the relationship between Spanish provinces' EXPY and GDP per capita. As can be seen in the figure, although there is a positive correlation between both variables, it is not very strong. If we run a simple regression, GDP per capita will only explain 13per cent of the variation in EXPY across Spanish provinces. This explanatory capacity is much lower than the one found by HHR between countries' GDP per capita and EXPY; however in that latter study the variability in GDP per capita across countries' was much larger than the variability in GDP per capita across Spanish provinces. Notwithstanding these differences, we should ask ourselves why GDP per capita has a lower capacity to explain differences in EXPY across Spanish provinces. The answer seems to lie in the share of primary products in Spanish provinces' total exports. As developing countries have comparative advantage in primary products, these commodities' PRODY is low. Hence, those Spanish provinces specialised in primary products have an EXPY which is lower than the one expected from their GDP per capita; this gap will be specially severe when Spanish provinces export varieties of primary products in which developing countries' command a large comparative advantage. As shown in the figure, the gap between the expected EXPY and the actual EXPY is very pronounced for provinces such as Las Palmas, Tenerife and Almería, that in 2005 were specialised in varieties of agricultural products, such as tomatoes or cucumbers, where developing countries command a large comparative advantage. If we control for the share of primary products in provinces' total exports, the explanatory capacity of the model raises to almost 40 per cent[3].

[FIGURE 1 AROUND HERE]

Table 1's last column presents EXPY's average annual growth rate between 1994 and 2005. It is important to note that during all the period varieties' PRODY values are fixed. Hence, changes in provinces' quality-adjusted EXPY can only occur through changes in the relative share of each variety in provinces' exports. As can be seen in the bottom of the table, the average annual growth rate in the 1994-2005 period was 0.46%. There are 33 provinces that improve their quality-adjusted EXPY and 17 provinces that deteriorate their quality-adjusted EXPY. Ávila is the province that presents the highest annual average growth (6.67%), followed by Granada (3.31%), Zamora (2.67%), Málaga (2.44%) and Cuenca (1.98%). On its hand, Tenerife is the province with the largest drop in quality-adjusted EXPY (-6.51), followed by Las Palmas (-5.24), Salamanca (-2.45), León (-1.79%) and Ourense (-0.77%).

It is important to explain the large drops in Canary Islands' provinces (Las Palmas and Tenerife) EXPY between 1994 and 2005. Both in 1994 and 2005, tomatoes were the largest contributors to Canary Islands' provinces EXPY. In this commodity the high-quality variety's PRODY value is much larger than the medium-quality variety's PRODY value. In 1994, Canary Islands' provinces tomatoes exports' unit value was located in the high-quality range, which led to high EXPY figures for Las Palmas and Tenerife. However, in 2005 tomatoes exports' unit value was located in the medium-quality range, which led to much lower EXPY figures and, hence, to large drops in Canary Islands' provinces EXPY between 1994 and 2005.

At the end of table we analyse whether differences in growth rates across Spanish provinces are governed by a convergence process in EXPY. Firstly, we compute the standard deviation of the (log) EXPY in 1994 and 2005. The evolution of this variable tells us whether there has been a reduction in the dispersion of EXPY across Spanish provinces, or σ- convergence. We can see that there is a reduction in the dispersion of the EXPY across Spanish provinces in the 1994-2005 period as the standard deviation drops from 0,180 to 0,159. Secondly, we compute β-convergence, which analyses the relationship between initial (log) EXPY and subsequent EXPY growth. The coefficient is negative and statistically significant, which shows that, as average, provinces that started with a lower EXPY achieved a higher EXPY growth than provinces that started with a higher EXPY. Hence, according to these results, there has been a convergence in EXPY across the Spanish provinces in the 1994-2005 period.

4. Exports' productivity and economic growth

In this section we analyse econometrically whether regions specialised in high-productivity exports have grown faster than regions specialised in low-productivity exports. In order to control for differences in employment rate across provinces, we use value added per worker growth, instead of GDP per capita growth, as our dependent variable. We estimate the following regression equation:

$$y_i\_growth = \beta_0 + \beta_1 \log(EXPY_i) + \beta_2 \log(y_i) + \beta_3 \log(h_i) \qquad (5)$$

where y_i_growth is the average annual growth rate of value added per worker in province i, *EXPY* the initial exports' quality-adjusted productivity, y_i the initial value added per worker and h_i the initial human capital level. Value added per worker is included in the equation because, according to the HHR model, it is the productivity level of exports relative to value added per worker which determines provinces' growth opportunities. In particular, provinces with an EXPY which is higher than the one predicted by their value added per worker will have opportunities to transfer resources from less productive activities to more productive activities. Finally, following HHR, human capital is also introduced in the equation. These authors show that differences in EXPY across countries are related to differences in human capital; on the other hand, human capital can also affect a country's growth prospects. In order to avoid the EXPY coefficient from getting human capital's explanatory power, this latter variable is also included in the model[4]

Value added per province data are obtained from Spanish Statistical Institute's (INE) Regional Economic Accounts database (www.ine.es)[5]. Data on occupied population is obtained from the Instituto Valeciano de Investigaciones Económicas (Ivie) database (www.ivie.es). Human capital is proxied by the percentage of occupied population that have upper-secondary or tertiary studies. Those data are also obtained from the Ivie database. The period of analysis is 1994-2004. In order to increase the number of observations in the regression analysis, we divide the 10 year period in two five-years growth intervals.

Table 2 presents the results of the regression analyses. In Column (1) we estimate a pool OLS model with the observations of the two five-years intervals. The coefficient for quality-adjusted EXPY is positive, which denotes that those Spanish regions that specialise in more productive goods, relative to labour productivity, achieve higher rates of growth. However, by a very small margin, the coefficient is not statistically significant at 10 per cent. The coefficient for the initial value added per worker is negative and statistically significant and the coefficient for human capital, although positive, is not statistically significant. At the bottom of the column, we include the p-value of the Moran's I statistic to test for spatial autocorrelation of the residuals. According to this coefficient we cannot reject the null hypothesis of no spatial autocorrelation of the residuals.

[TABLE 2 AROUND HERE]

Canary Islands' provinces (Las Palmas and Tenerife) initial quality-adjusted EXPY affects severely the statistical significance of this variable's coefficient. As explained in the previous section, the largest contributor to Canary Islands' EXPY are tomatoes. In this commodity the high-quality's PRODY value is much larger than the medium-quality's PRODY value. Canary Islands' tomatoes unit values are in the medium-quality/high-quality border and small changes in the unit values lead to large swings in the Las Palmas' and Tenerife's quality-adjusted

EXPY values, which affect, in turn the regression analysis. When we introduce a dummy variable to control for the special behaviour of Canary Islands' provinces (Column (2)), there is an increase in the value of the quality-adjusted EXPY coefficient and it becomes statistically significant at 5 per cent.

The conclusions of the pooled OLS model are valid as long as there are not province-level effects. At the end of Column (3) we test whether there are time-invariant province-level characteristics that may affect the validity of the estimation. The F-test shows that we can reject the null hypothesis that all province-level effects are zero. According to this result, we should use a fixed-effects model to analyse whether there is a relationship between a province initial quality-adjusted EXPY and subsequent growth. However, we should stress that the weakness of the FE model is that there is a large reduction in the degrees of freedom compared to the pool estimate.

As can be seen in Column (3) the fixed effects model estimation yields a positive and statistically significant quality-adjusted EXPY coefficient. This result is in line with the one obtained in the pool estimate and confirms HHR model's prediction on the positive association between a country's EXPY and subsequent growth. Moreover, in this last estimation, the coefficient for human capital is positive and statistically significant. To sum up, both the pool and the fixed effects estimations find a positive link between Spanish provinces exports' initial productivity-level and subsequent growth. According to these results, Spanish provinces that have specialised in more productive goods have achieve higher growth rates than Spanish provinces specialised in less productive goods.

5. Conclusions

There is a long standing argument in the literature that specialising in some goods is more growth promoting than others. Recently, Hausmann et al. (2007) have developed a model that establishes a new link between specialisation and economic growth. These authors argue that products differ in their implied level of productivity and show that countries specialised in high-productivity products, relative to their GDP per capita, grow faster than countries specialise in low-productivity products. The aim of this paper has been to test whether this relationship also takes place at the regional level. In particular, we analyse whether Spanish provinces specialised in high-productivity exports have grown faster than provinces specialised in low-productivity exports. In order to do that, firstly, we calculate the productivity level associated to each province exports, controlling for quality differences within a product category. Our calculations show that there are large differences in exports' productivity-level across Spanish provinces; however, during the last decade there has been a convergence process in exports' productivity level across Spanish provinces. Provinces that are located at the top of the ranking are characterised by a large specialisation in products with high productivity levels, such as motor vehicles, parts and accessories of motor vehicles, chemical products and medicaments. On the contrary, provinces that are located at the bottom of the ranking are characterised by a large specialisation in commodities with low productivity levels, such as agricultural products and minerals.

Secondly, we regress the average growth rate in labour productivity on the initial exports' productivity level and other control variables. Using different estimation techniques, our results show that there is a positive association between a province's exports' productivity level and subsequent economic growth. According to our results, Spanish provinces that have specialised in more productive goods, relative to their labour productivity, have grown faster than Spanish provinces that have specialised in less productive goods. Hence, our results show that the relationship between exports' productivity and growth also holds at a regional level.

Acknowledgments: I would like to thank the Basque Institute of Competitiveness and the Education, Universities and Research Department of the Basque Government for the financial support to undertake this research. I am grateful to Patricia Canto, two anonymous referees and participants at the XI Encuentro de Economía Aplicada for many helpful suggestions. Any errors or omissions remains the author's own responsibility.

Data Appendix

As explained at the end of Section 2, we use a sample of countries that reported export and GDP per capita data in 2002, 2003 and 2004 to calculate varieties' PRODY. In order to obtain average values for the 2002-2004 period, we have to transform current exports' values into constant exports' values. To perform this operation, ideally, we would like to have exports' price indexes for each country and each HS product included in the sample. Since we do not have those data, we decide to use the US Harmonised System import price index in order to proxy the evolution of export prices in the world; these data were obtained from the Bureau of Labour Statistics. For each country and HS product, we add up the 2002, 2003 and 2004 (constant) exports and quantity data. With this procedure we only allow each country to have one variety per each product. Not all exports' observations provide a quantity measure that allows the calculation of the unit value; for example, in our sample such observations account for 7.5 per cent of total sample's exports. The Comtrade database offers export observations that, in most cases, report a net weight figure, which allows a $ per kilogram unit value calculation. In other cases, a supplementary quantity figure is reported as well. In order to compare a commodity's unit value across years and countries, all unit values should be calculated with the same quantity unit. For each commodity we analyse which is the quantity unit (kilograms, items, litres,...) that maximises the number of observations. In the majority of cases the weight in kilograms is the quantity unit chosen. This procedure obliges us to remove from the sample some observations that allow the calculation of a unit value but do not use the quantity measure that has been chosen for the product. The removal of those observations raises the percentage of exports for which a valid unit value cannot be computed to 18.4 per cent of total sample's exports. Finally, in order to minimise measurement errors, we remove observations where the unit value is below or equal to the 1st percentile and equal or above the 99th percentile. The removal of those observations further raises the number of excluded exports to 19.8 per cent of total exports. This figure also includes those exports that are dropped from the sample because there were not enough unit value observations per product to calculate varieties' PRODY.

Spanish regions' exports data are obtained from the *Agencia Tributaria*'s database. The database offers annual data on international trade, disaggregated by Spanish provinces and in the Common Nomenclature (CN) classification. The CN is an 8 digit extension of the HS classification used by European Union countries. Hence, there are no difficulties, at first hand, to transform NC products into HS products. However, the *Agencia Tributaria* reports trade data in the NC classification's revision, and hence in the HS classification's revision, that is in use in each year. This fact introduces some limitations in the calculation of provinces' EXPY. As explained above, we use the 1992 version of the HS classification to calculate the varieties' PRODY. In order to avoid biases, we only calculate provinces' EXPY figures with those products whose classification does not change between 1994 and 2005. Those products represent 90% of total provinces' exports.

In order to calculate provinces' EXPY we assign each HS 6 digit export observation to the low, medium or high variety, depending on which quality range the unit value falls. In order to overcome the effect of the evolution of prices and exchange rates on the calculation of unit values, as explained before, we use the US import price index to transform current values into 2000 constant values. Observations that lack a valid unit value enter the EXPY calculation multiplying their value by the non quality-adjusted PRODY. Finally, in the calculation of Spanish regions' EXPY we do not include some products with a high PRODY, such as sailboats and motorboats, that have a second-hand export market. In most of the cases those products are not produced in Spain; however, as some of them are sold as second-hand products in foreign countries, their inclusion in the EXPY calculation could bias some provinces' sophistication index[6]. We also exclude Badajoz's exports of natural gas; those exports are assigned to Badajoz because the gas pipeline crosses this province in its way to Portugal.

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Table 1. Spanish provinces quality-adjusted EXPY (2000 constant PPP $)

Province	1994	2005	Average annual growth (%)
A Coruña	12389	15053	1.79
Álava	16695	17855	0.61
Albacete	14896	17089	1.26
Alicante	11827	14450	1.84
Almería	10752	10209	-0.47
Asturias	15800	15590	-0.12
Ávila	9214	18752	6.67
Badajoz	11442	13541	1.54
Balearic Islands	17047	16244	-0.44
Barcelona	15846	17777	1.05
Burgos	15325	15435	0.07
Cáceres	12904	12211	-0.50
Cádiz	14468	13424	-0.68
Cantabria	14325	16204	1.13
Castellón	15786	17820	1.11
Ciudad Real	12144	14313	1.51
Córdoba	11629	13101	1.09
Cuenca	14305	17748	1.98
Girona	15809	18671	1.52
Granada	10769	15409	3.31
Guadalajara	17005	16344	-0.36
Guipúzcoa	14895	17150	1.29
Huelva	17502	18870	0.69
Huesca	15689	18369	1.44
Jaén	14515	16243	1.03
Las Palmas	17051	9431	-5.24
León	18111	14854	-1.79
Lleida	13618	14722	0.71
Lugo	13347	12669	-0.47
Madrid	16811	18263	0.76
Málaga	13382	17452	2.44
Murcia	13184	15524	1.50
Navarre	16990	17686	0.37
Ourense	18595	17078	-0.77
Palencia	17873	17474	-0.20
Pontevedra	16263	15285	-0.56
Rioja (La)	12418	13514	0.77
Salamanca	20261	15427	-2.45
Segovia	17000	16154	-0.46
Sevilla	13500	13791	0.19
Soria	15375	18606	1.75

Table 1. (cont.)

Province	1994	2005	Average annual growth (%)
Tarragona	14297	16296	1.20
Tenerife	21512	10259	-6.51
Teruel	15724	15462	-0.15
Toledo	13619	13708	0.06
Valencia	14412	16691	1.34
Valladolid	14899	16213	0.77
Vizcaya	14454	16721	1.33
Zamora	9325	12640	2.80
Zaragoza	17555	16829	-0.38
Average	14851	15612	0.46
Standard deviation (log EXPY)	0,180	0,159	
β coefficient	-7.324 (-4.44)*		

*: statistically significant at 1%.
Source: authors' calculation based on Comtrade and Agencia Tributaria databases.

Table 2. Cross-provinces growth regressions

	(1) OLS	(2) OLS	(3) FE
Log initial value added per worker	-0.047	-0.049	-0.185
	(-4.58)***	(-5.07)***	(-11.06)***
Log initial quality-adjusted EXPY	0.017	0.020	0.018
	(1.63)	(2.02)**	(2.39)**
Log human capital	0.007	0.008	0.015
	(1.07)	(1.27)	(1.78)*
Constant	0.345	0.316	1.680
	(2.77)***	(2.65)***	(9.30)***
Period	1994-2004	1994-2004	1994-2004
Interval	5 years	5 years	5 years
Number of observations	100	100	100
Degrees of freedom	95	94	46
Spatial autocorrelation of the residuals: Moran's I's p-value	0.544	0.553	0.409
F-test that all province-level effects are zero (p-value)			0.00
R-squared	0.23	0.33	0.75

Column (3) - Column (6) regressions include period dummies. Robust t-statistics in parentheses. *** statistically significant at 1%; ** statistically significant at 5%; * statistically significant at 10%.

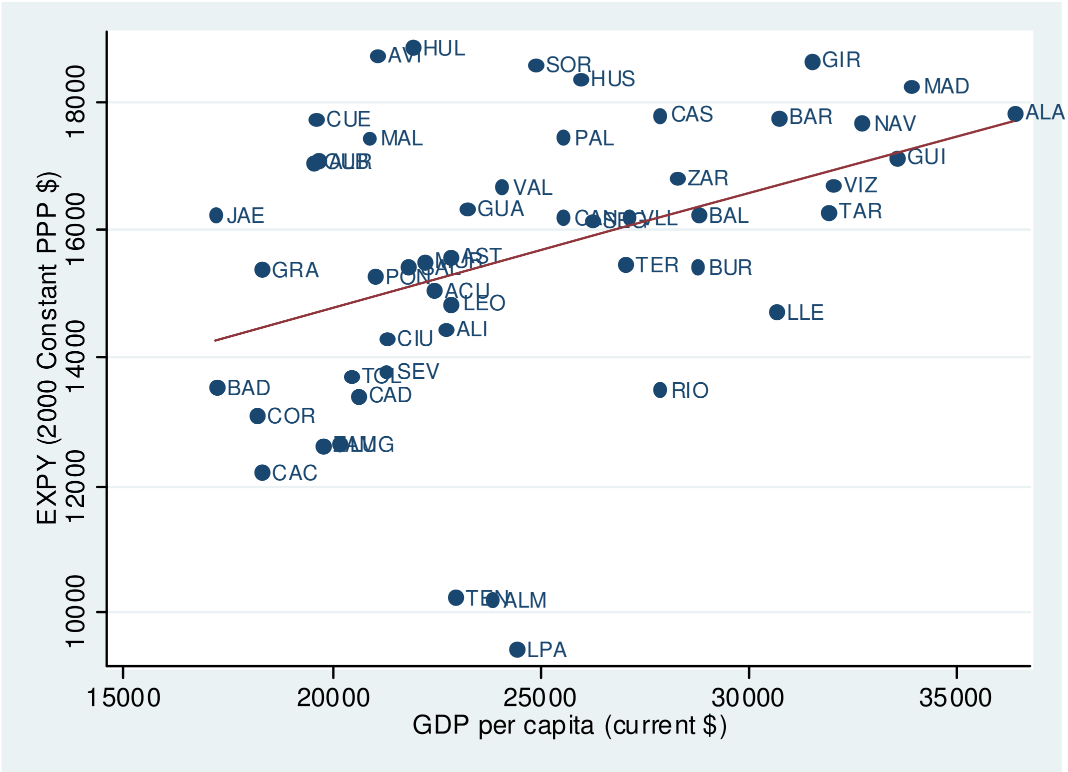

Figure 1. Relationship between Spanish provinces' GDP per capita and quality-adjusted EXPY, 2005

[1] HAUSMANN and KLINGER, 2007 show that there are differences across countries in their possibilities to upgrade from lower productivity products to higher productivity products.

[2] As in HHR, we use three years in order to attenuate the biases generated by observations driven by year-specific circumstances.

[3] This analysis poses the additional question of how some Spanish provinces can be competitive in agricultural exports that are associated with a low productivity level. The answer seems to be linked to the European Union's (EU) protectionist policy on agricultural products. As the EU imposes border barriers on some agricultural products, some EU members can still be competitive in exporting agricultural commodities with a low EXPY to other EU members.

[4] HHR also include the quality of the institutions in the growth regression as it may also explain the differences in EXPY across countries. As the quality of institutions differ mildly within regions we do not include this variable in the regression.

[5] As there are no GDP deflators for provinces, we use autonomous communities' (NUTS 2) GDP deflators to transform current values into constant values. It is important to note that during the period of analysis there have been changes in the methodology used to calculate provinces GDP (1986's methodology, 1995's methodology

and 2000's methodology). In order to control for those changes, and taking into account that in some years provinces' GDP figure is available in more than one methodology, we calculate the real growth rates during the years that compose the 1995's methodology period and the 2000's methodology period. Afterwards, we use those growth rates to extend the 1986's methodology period's GDP figures.

[6] Following the same reasoning, in the case of Balearic Islands, we also exclude aircraft exports.